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(54) METHOD AND APPARATUS FOR MANUFACTURING AND LAYING OUT AN UMBILICAL

VERFAHREN UND EINRICHTUNG ZUR HERSTELLUNG EINES VERBINDUNGSKABELS

PROCEDE ET APPAREIL DE FABRICATION ET DE POSE D'UN CABLE OMBILICAL

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Description

The present invention relates to a method of manufacturing and laying a plurality of elongate elements into a cable cord, or umbilical, comprising a core element, a plurality of conduits and/or cables situated outside the core element, filler material around and between the conduits/cables and optionally a protective sheath surrounding the conduits and filler material, which core element is advanced along a feed line and the conduits and/or cables are fed onto the outside of the core element and laid in a helix.

The invention also relates to a machine for manufacturing of such an umbilical, which machine comprises a pulling means specifically for the core element and reels of coiled conduits and/or cables, which reels are spaced apart around the core element, and are rotatable about the core element for helical laying thereon, and pulling means acting on the conduits and/or cables.

From British patent application GB-2038988 there is known a method and means for producing a multipipe conduit from a plurality of pipes and a central core as said pipes and central core are drawn in their longitudinal direction. The pipes are secured at the contact end in a non-twisted relationship around the central core.

GB-A-2 192 966 shows a method and an apparatus for producing helically wound pipe bundles. A group of pipes is wound together to form a continuous combination conduit from the individual supply pipes, conduits and cables that are intended to be laid in one operation in bundled form from a lay vessel at sea.

Further examples of the prior art are shown in GB-1141014, GB-1210206 and GB-1423059. An example of a previously proposed pipe bundle cable is shown in EP-A-0 177 475.

The present umbilical is a further development of the concept shown in EP-A-0 177 475. The umbilical is a composite structure capable of transporting hydraulic fluids, chemicals, electrical and optical signals and electrical power. The conduit for chemical transport is usually placed in the center, while those for electrical signals and power and the hydraulic pipes are placed peripherally around the central element or core element. The peripherally situated elements are wound into a helix around the central pipe. Each element is free to move longitudinally in relation to the other elements. The cable cord is wrapped with a band, and the outer sheath is a thermoplastic layer extruded onto the cable cord.

The types of materials used are evaluated and selected on the basis of information about the medium to be transported, the expected lifetime and other operational criteria.

The core element may be a metal tube for conducting a liquid or may be an electrical cable for transmission of power or signals. As a metal tube it may be used, e. g, for injection of methanol into a drilling well. The materials in the metal tubes may be selected on the basis of high strength and good corrosion resistance. Examples of such materials are Super Duplex (UNS S 32750) /Duplex (UNS S 31803). Another possible material is titanium, grade 9.

The outer sheath may consist of polyethylene or polyurethane that is extruded onto the cable in a final step. Although not restrictive for the scope of the invention, a typical exterior diameter for the umbilical or cable cord would be from 50 mm to 200 mm.

It should also be noted that the umbilical enables the attainment of a small radius of curvature, meaning that it can be coiled up onto a maneuverable drum. Some plastic deformation of the steel tubes will occur, however. Still, coiling and uncoiling of the umbilical may be undertaken a considerable number of times.

As mentioned above, the new umbilical may be coiled up on a drum or carousel of a relatively small diameter. This is made possible by virtue of the fact that the conduits/cables are spiralled around the core element and are capable of bending almost freely about their own neutral axis, while not being subjected to tension or pressure as a result of bending around the neutral axis of the cable cord. Because the elements are freely movable longitudinally, it is sufficient to have a twist lay length of about 10 meters per revolution (depending on the cable dimension). The axial forces to which the cable is subjected are absorbed by the metal tubes. The long twist lay length results in very slight torsional forces in the cable when stretched, rendering it unnecessary to introduce additional elements in order to stabilize the cable in torsion.

According to the present invention, a method of the type described in the above introduction is provided, which method is characterized in that some of the filler material, in the form of inner, elongate channel elements, is first fed in helical form onto the outside of the core element, whereafter the conduits and/or cables are introduced flush with the channels in the channel elements, and that the remaining filler material, in the form of outer channel elements, is then fed in helical form onto the outside of the conduits and/or cables such that the channels in the channel elements are flush with the conduits/cables, as all of said elongate elements are laid and held together as a collective bundle and form said umbilical.

Advantageously the elongate channel elements will be brought together as they are being laid, and are held together with the aid of self-locking means on the longitudinal edges of the channel elements.

Advantageously a band/tape may be wrapped helically around the elongate elements to further ensure that the elements are held together after the laying.

The protective sheath may be applied as a separate, subsequent operation, alternatively as a final production step in a continuous operation after the laying.

In accordance with the present invention, there is also provided an umbilical constructed as described in the introduction above, which is characterized in that the

filler material is in the form of inner, elongate channel elements having outwardly opening channels adapted for receipt of the conduits/cables, and outer, elongate channel elements having inwardly opening channels adapted for receipt and final enclosure of the conduits/cables.

Advantageously the elongate channel elements are provided along the lateral edges thereof with self-locking fastening means which hold adjacent channel elements together around the core element.

As an alternative, the actual core element may itself be a separate umbilical on a smaller scale.

According to the invention there is also provided a machine of the type mentioned in the introduction, which is characterized in that the machine comprises at least one other set of reels with coiled filler material in the form of longitudinal channel elements, which reels are correspondingly spaced apart around the core element, and are rotatable about said core element for helical laying of the channel elements on the core element.

Each reel may advantageously be secured as a cantilever to a turntable for unobstructed coiling of the elongate elements.

The machine may have a plurality of turntables provided with reels, where the turntables are spaced apart in the feed direction of the cable.

Conveniently at least one set of reels on a turntable, in addition to being rotatable about its own longitudinal axis, is rigidly fixed to the turntable and undergoes one revolution about its transverse axis with one revolution of the turntable. Conveniently, at least one set of reels on a turntable, in addition to being rotatable about its own longitudinal axis, may be pivotably attached to the turntable in such manner that the longitudinal axis of the reels remains horizontal as the turntable revolves.

The machine may to advantage comprise alignment apparatuses for straightening out the coiled conduits/cables before they are laid into the channels of the inner channel element.

At the outlet from the machine a band winding apparatus may advantageously be placed.

An extruder may be placed at the outlet from the machine to continuously apply a protective sheath around the cable cord.

In the following a preferred embodiment of the invention will be described with reference to the appended drawings, where:

Fig. 1 is a schematic view of a machine for manufactuing of the umbilical according to the invention,

Fig. 2 is an elevational view of a reel station seen from a section A-A in Fig. 1,

Fig. 3 is an elevational view from the back of a reel station seen from section B-B in Fig. 1,

Fig. 4 is a view of a reel station seen from section C-C in Fig. 1,

Fig. 5 is a view from the front of a reel station seen from section D-D in Fig. 1,

Fig. 6 is a schematic transverse sectional view of an umbilical showing its construction,

Fig. 7 is a section of an inner, longitudinal channel element,

Fig. 8 is a section of an outer longitudinal channel element,

Fig. 9 is a cross section through an alternative umbilical having a cable as the core element,

Fig. 10 is a view of the umbilical according to Fig. 9, in perspective transverse section,

Fig. 11 is a view of an alternative embodiment of the umbilical, and

Fig. 12 is a simplified view of an apparatus and a method for laying short cable cords.

We refer first to Figures 6-10 showing the construction of a cable cord or "umbilical" to be produced with the machine shown in Fig. 1. A steel tube forms the central core element 5. This is designed to transport chemicals such as methanol, for example, for injection into a well. On the outside of core element 5 lie a plurality of inner, elongate channel 1 elements 6, illustrated in more detail in Fig. 7. In the embodiment shown there are placed five such channel elements 6, completely enclosing core element 5. This number may, of course, be altered according to the requirements of the individual umbilical. Channel elements 6 have self-locking fastening means 20 along the lateral edges thereof to hold adjacent channel elements 6 together around core element 5. Channel elements 6 also have outwardly opening channels 21 adapted to receive conduits 7 and cables 8. The number of conduits and cables may vary according to need, and in certain applications either the conduits or the cables may be omitted. Outer, elongate channel elements 9 lie on the outside of the inner channel elements 6 and have corresponding inwardly opening channels 22 adapted for receipt and final enclosure of conduits 7 and cables 8. The outer channel elements 9 are also provided along the lateral edges thereof with self-locking fastening means 20 which hold adjacent channel elements 9 together around the inner channel members 6 or core element 5. The outer channel element 9 is shown in more detail in Fig. 8.

Both the inner and outer channel elements 6, 9 may have voids 24 designed to reduce weight and use of material. In addition, precise profile dimensions require uni-

form material thicknesses, necessitating the voids 24. It should also be noted that there is a clearance provided between the conduits/cables and the joined channel elements 6, 9, to enable conduits 7 and cables 8 to move freely within the channel elements.

Fig. 9 shows an alternative embodiment of the umbilical where the central core is made up of an additional cable cord. As shown, the electrical cables run within the central core element and the steel tubes for hydraulic fluid are situated externally to the core element and are freely movable within channel elements 6, 9.

Fig. 10 shows the umbilical according to Fig. 9, in perspective transverse section.

Channel elements 6, 9 may consist of extruded PVC profiles that are delivered in long lengths on reels. The outer, protective sheath 1 may consist of polyethylene (PE) that has been extruded onto the cable cord. Polyethylene will be chosen due to its excellent mechanical properties and bending capabilities. Alternatively, sheath 1 may be made of polyurethane, or optionally of any suitable material whatsoever.

We refer now to Fig. 1 to describe the construction of the machine. At the input end of the machine (to the left in Fig. 1) core element 5 is drawn into the machine at station I with the aid of a pulling means 15. This pulling means 15 may be a so-called caterpillar pull, or alternatively a linear winch. As mentioned before, core element 5 may in certain applications be a steel tube that is uncoiled from a reel. Core element 5 advantageously passes through an alignment apparatus (not shown) before entering the machine. Core element 5 follows a rectilinear movement into the machine, undergoing no rotation about its own axis. Core element 5 is fed through the machine at the speed permitted by the machine, as well as the speed permitted by a reception mechanism (not shown). The reception mechanism may consist of a reclining carousel. Typical maximum speed would be 30 m/min.

Station II in Fig. 1 shows a turntable with reels 3 attached thereto. Fig. 2 shows station II seen from the front. The illustrated embodiment has five reels 3, but any suitable number is possible. Each reel is rotatable about its longitudinal axis 14. If desired, each reel 3 may be provided with braking capability. Reels 3 carry coiled up inner, elongate channel elements 6, e.g., extruded PVC elements. Each reel 3 is mounted on two cantilevered arms on the large turntable 10. The coiled channel elements 6 are fed in toward core element 5 and pass into a funnel apparatus 30 as turntable 10 revolves, and are laid helically onto the outside of core element 5.

A station III also has a plurality of reels 4, but these carry coiled up conduits 7, or cables 8. Each reel 4 is mounted on and pivotably attached to another large turntable 11, in such manner that the longitudinal axis of the reels (uncoiling) remains horizontal while the large turntable 11 rotates. As is apparent from the figure, the steel conduits 7, optionally cables 8, pass through alignment apparatuses 25 before being laid helically in channels 21 of the inner channel elements 6 during rotation of turntable 11. The conduits 7 or cables 8 are not, however, twisted about their own axes.

Station IV, like station III, has reels 4 containing coiled up cables 8, optionally conduits 7. Whether conduits 7 emerge from station II or from station IV, or some conduits 7 and some cables 8 come from the same station, is of no import per se. In most respects station IV functions in like manner to station III. Before cables 8, optionally conduits 7, are laid onto the outside of the umbilical, they also here pass through alignment apparatus 25.

Station V comprises a plurality of pulling means 16 which frictionally engage conduits 7 and cables 8 which, in turn, frictionally take hold of the inner channel elements 6 and draw these off their respective reels 3, 4 in stations II, III and IV. It should be noted, in addition, that core element 5 is urged through the machine with the aid of the pulling means in station I.

Station VI also has a turntable 10 and reels 3, but with coiled up outer channel members 9, e.g., in the form of extruded PVC elements. Channel elements 9 are fed into a funnel apparatus 31 are laid helically onto the outside of core element 5, as all the elongate elements are laid into the finished umbilical. Station VI otherwise functions in a manner quite similar to that of station II.

As mentioned above, the elongate elements are laid, or twisted together, in the funnel apparatus 31 in station VII and assume their final form. Station VII also comprises a band winding apparatus which wraps a tape or band around the laid cable-cord to help hold it together.

An optional final station (not shown) may apply the outer coating, e.g, polyethylene, in a continuous operation, or this may be done subsequently as a separate operation.

Conduits 7 and cables 8 pass through the mentioned alignment apparatuses 25 for removal of inherent "curvature" resulting from their being coiled up.

In Fig. 1 are shown four reel stations with five reels for each station. The number of stations and number of reels may be varied according to the specific cable to be produced.

Fig. 3 is a rear view of reel station III, showing a mechanism that helps hold reels 4 in a fixed position as turntable 11 revolves. Fig. 4 is a view from the top of reel station III or IV. The longitudinal axis 17 of reels 4 is held substantially horizontal by means of the mechanism shown in Fig. 3 and the effect of gravity on reels 4. Reels 4 also have braking capability, permitting application of the requisite tension to conduits 7 and cables 8. Fig. 5 shows reel station IV viewed from the front and illustrates the horizontal position for the longitudinal axes of drums 4 during their movement around core element 5.

The velocity of rotation for the machine may be about 3 revolutions/min. Rotation of the turntables is effected by engine driven supporting rollers with individual drive, that are coupled together in a central electrical

control unit. All turntables rotate synchronously during the cable laying, but may be driven individually for loading/changing of reels, etc. As mentioned above, the reels for the channel elements are fixedly mounted to the turntables. The channel elements will thereby be twisted so as to follow the spiralling of the cable.

The reels for conduits 7 or cables 8 are suspended in fork-like holders. The holders are formed asymmetrically so that the reel axis, with the aid of gravity, remains horizontal below the shaft of the holder.

The holder shaft is mounted in the turntable and is oriented toward a point on the machine's axis of rotation by means of supporting journals to the carousel preceding it. The reels will therefore always be directed toward this point.

The freely suspended part of the tubing will maintain a constant length during rotation of the carousel. The distance between the reel and the funnel apparatus allows the tube to be pulled out from the reel with very little angular deflection.

Another advantage of the fork design for the reel suspension is that the reels may be loaded from the front. Thus it is possible to use a carriage to move the reels into the fork instead of using a crane, which is the conventional practice. Installation by use of a carriage is a simpler and safer method.

To stabilize the holders, i.e., to avoid oscillations and outward swing due to centrifugal force, the rear end of the holder shaft is equipped with arms that constantly point downward. The arms are reciprocally connected with ball joints and stays.

When hydraulic tubes are wound up on reels to be suspended in the cable twister, the tubes will be subjected to plastic deformation. When the tubes are to be gathered together at the laying or twisting point it is important that they are straight. Only then is it possible for them to be laid down in the channel elements. On the path from the reel to the laying or twisting point there is placed an alignment apparatus, as mentioned above. The suspension means for the alignment apparatus rotates to keep the apparatus at all times in the correct position relative to the tube.

Fig. 11 shows an alternative embodiment of the umbilical according to the invention. Instead of using the previously mentioned channel elements 6, 9, a PVC tube of the "electrical tube" type is used. These "electrical tubes" may have different dimensions in order to accommodate cables and tubes of various sizes. This type of umbilical is specifically designed for production of short cable lengths, e.g., up to 500 m, where the cord has the same properties with regard to strength and bending as previously described. The short length makes it possible to lay the cable manually without using an expensive laying, or cable twisting, machine. The channel elements may therefore be replaced by the electrical tubes or plastic tubes that are sleeved manually over the individual conduits and single cables.

Fig. 12 is a simplified view of an apparatus and a method for laying this type of short cable cord. The separate steel conduits 7 are welded together along the full length of the cable and tested according to qualitative criteria. These conduits 7, together with any cables 8 cut to the same length, form the individual elements of the umbilical 2. All the individual elements are laid upon trestles 30. The individual elements are attached at one end to a rotatable disc or turntable 31, with the same individual placement as in the umbilical cross section. Each individual element is attached to a swivel 32 on disc 31 permitting rotation about the elements' longitudinal axis. Before the elements are attached to turntable 31 they are threaded through a matrix 33, i.e., a disc having the same configuration as the cable cross section. This matrix 33 is attached to a carriage 34 which may be drawn along the cable.

Each individual element is drawn up and the plastic tubes 35 are sleeved onto the free end. The plastic tubes are delivered in short lengths and must be spliced together after being sleeved onto the elements. The splicing can be done with a splicing apparatus based on gluing or welding.

After the elements are laid in the plastic tubing, they are stretched out at the free end so that they lie taut across the trestles.

The cable is laid, or twisted, together by advancing carriage 34 along with the cable at the same time as the turntable is rotated slowly about the cable axis 36. Immediately behind the matrix the cable is wrapped with tape 37 so that the cable cross section is securely locked into place.

If necessary the cable cross section may be stabilized with the aid of filler elements that are laid in like the other elements, and/or by injecting hardening foam into the cross section. After the laying, the outer sheath is extruded onto the cable, as described previously.

Claims

1. A method of manufacturing and laying a plurality of elongate elements into an umbilical (2) comprising a core element (5), a plurality of conduits (7) and/or cables (8) situated outside the core element (5), filler material around and between the conduits/cables and optionally a protective sheath (1) surrounding the conduits and filler material, which core element (5) is advanced along a feed line and the conduits (7) and/or cables (8) are fed onto the outside of the core element (5) and laid in a helix, **characterized in** that some of the filler material, in the form of inner, elongate channel elements (6), is first fed in helical form onto the outside of the core element (5), whereafter the conduits (7) and/or cables (8) are introduced flush with the channels (21) in channel element (6), and that the remaining filler material, in the form of outer channel elements (9), is then fed in helical form onto the outside of the

conduits (7) and/or cables (8) such that the channels (22) in the channel elements (9) are flush with the conduits/cables, as all of the elongate elements are laid and held together as a collective bundle and form said umbilical (2).

2. Method according to claim 1, **characterized in** that the elongate channel elements (6, 9) are brought together as they are being laid, and are held together with the aid of self-locking means (20) on the longitudinal edges of the channel elements (6, 9).

3. Method according to claim 1 or 2, **characterized in** that a band is wrapped helically around the elongate elements (6,7,8,9) to further ensure that the elements are held together after the laying.

4. Method according to claims 1-3, **characterized in** that the protective sheath (1) is applied as a final production step in a continuous operation after the laying--alternatively as a separate, subsequent operation.

5. An umbilical (2) comprising a core element (5), a plurality of conduits (7) and/or cables (8) situated outside the core element (5), filler material around and between the conduits/cables and a protective sheath (1) surrounding the conduits and filler material, where the filler material is laid in a helix around the core element (5),
characterized in that the filler material is in the form of inner, elongate channel elements (6) having outwardly opening channels (21) adapted for receipt of the conduits (7)/cables (8), and outer, elongate channel elements (9) having inwardly opening channels (22) adapted for receipt and final enclosure of the conduits (7)/cables (8).

6. An umbilical according to claim 5, **characterized in** that the elongate channel elements (6, 9) are provided along the lateral edges thereof with self-locking fastening means (20) which hold adjacent channel elements (6, 9) together around the core element (5).

7. An umbilical according to claim 5 or 6,
characterized in that the core element (5) may itself be a separate cable cord (Fig. 9) on a smaller scale.

8. A machine for laying a plurality of elongate elements into an umbilical (2), comprising a core element (5), a plurality of conduits (7) and/or cables (8) situated outside the core element (5), filler material around and between the conduits/cables and a protective sheath (1) surrounding the elements and filler material, which machine comprises a pulling means (15) specifically for the core element (5) and reels (4) containing coiled conduits (7) and/or cables (8), which reels (4) are spaced apart around the core element (5) and are rotatable about the core element for helical laying thereon, and pulling means (16) acting on the conduits (7) and/or cables (8), **characterized in** that the machine comprises at least one other set of reels (3) with coiled filler material in the form of elongate channel elements (6, 9), which reels (3) are correspondingly spaced apart around the core element (5), and are rotatable about said core element (5) for helical laying of the channel elements (6, 9) on the core element (5).

9. A machine according to claim 8, **characterized in** that each reel (3, 4) is secured as a cantilever to a turntable (10, 11) for unobstructed coiling of the elongate elements (6, 7, 8, 9).

10. A machine according to claim 9, **characterized in** that it has a plurality of turntables (10, 11) provided with reels (3, 4), where the turntables are spaced apart in the feed direction of the cable.

11. A machine according to claim 9 or 10,
characterized in that at least one set of reels (3) on a turntable (10), in addition to being rotatable about its own longitudinal axis (15), is rigidly fixed to the turntable and undergoes one revolution about its transverse axis (16) with one revolution of the turntable.

12. A machine according to claim 9, 10 or 11,
characterized in that at least one set of reels (4) on one turntable (11), in addition to being rotatable about its own longitudinal axis (17), is pivotably attached to the turntable in such manner that the longitudinal axis (17) of the reel remains horizontal as the turntable (11) revolves.

13. A machine according to claim 9, 10, 11 or 12,
characterized in that it comprises alignment apparatuses (25) for straightening out the coiled conduits (7)/cables (8) before they are laid into the channels (21) in the inner channel element (6).

14. A machine according to one or more of the claims 8-13,
characterized in that it comprises a band winding apparatus at the outlet from the machine.

Patentansprüche

1. Verfahren zum Herstellen und Anordnen mehrerer länglicher Elemente zur Bildung eines Verbindungskabels (2) mit einem Kernelement (5), mehreren Leitungen (7) und/oder Kabeln (8), die sich außerhalb des Kernelements (5) befinden, Füllma-

terial um die Leitungen/Kabel herum und dazwischen und gegebenenfalls einer die Leitungen und das Füllmaterial umgebenden Schutzhülle (1), wobei das Kernelement (5) entlang einer Zuführungsstraße vorwärtsbewegt wird und die Leitungen (7) und/oder Kabel (8) auf die Außenseite des Kernelements (5) zugeführt und in einer Schraubenlinie angeordnet werden,

dadurch gekennzeichnet, daß ein Teil des Füllmaterials in Form von inneren länglichen Kanalelementen (6) zunächst schraubenförmig auf die Außenseite des Kernelements (5) zugeführt wird, wonach die Leitungen (7) und/oder Kabel (8) bündig mit den Kanälen (21) im Kanalelement (6) eingeführt werden, und daß dann das verbleibende Füllmaterial in Form von äußeren Kanalelementen (9) schraubenförmig auf die Außenseite der Leitungen (7) und/oder Kabel (8) zugeführt wird, so daß die Kanäle (22) in den Kanalelementen (9) mit den Leitungen/Kabeln bündig sind, wenn alle länglichen Elemente angeordnet und als Sammelbündel zusammengehalten werden und das Verbindungskabel (2) bilden.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß die länglichen Kanalelemente (6, 9) bei der Anordnung zusammengebracht und mittels Selbstverriegelungsmitteln (20) an den Längsrändern der Kanalelemente (6, 9) zusammengehalten werden.

3. Verfahren nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß ein Band schraubenförmig um die länglichen Elemente (6, 7, 8, 9) gewickelt wird, um weiter zu gewährleisten, daß die Elemente nach der Anordnung zusammengehalten werden.

4. Verfahren nach den Ansprüchen 1 - 3, dadurch gekennzeichnet, daß die Schutzhülle (1) nach der Anordnung als letzter Herstellungsschritt in einem kontinuierlichen Arbeitsgang aufgebracht wird - alternativ als separater, anschließender Arbeitsgang.

5. Verbindungskabel (2) mit einem Kernelement (5), mehreren Leitungen (7) und/oder Kabeln (8), die sich außerhalb des Kernelements (5) befinden, Füllmaterial um die Leitungen/Kabel herum und dazwischen und einer die Leitungen und das Füllmaterial umgebenden Schutzhülle (1), wobei das Füllmaterial in einer Schraubenlinie um das Kernelement (5) herum angeordnet wird,

dadurch gekennzeichnet, daß das Füllmaterial in Form von inneren länglichen Kanalelementen (6) mit sich nach außen öffnenden Kanälen (21) zur Aufnahme der Leitungen (7)/Kabel (8) und äußeren länglichen Kanalelementen (9) mit sich nach innen öffnenden Kanälen (22) zur Aufnahme und Endumschließung der Leitungen (7)/Kabel (8) vorliegt.

6. Verbindungskabel nach Anspruch 5, dadurch gekennzeichnet, daß die länglichen Kanalelemente (6, 9) entlang ihren Seitenrändern mit selbstverriegelnden Befestigungsmitteln (20) versehen sind, die benachbarte Kanalelemente (6, 9) um das Kernelement (5) herum zusammenhalten.

7. Verbindungskabel nach Anspruch 5 oder 6, dadurch gekennzeichnet, daß das Kernelement (5) selbst in kleinerem Ausmaß eine separate Kabelschnur (Fig. 9) sein kann.

8. Maschine zur Anordnung mehrerer länglicher Elemente zu einem Verbindungskabel (2) mit einem Kernelement (5), mehreren Leitungen (7) und/oder Kabeln (8), die sich außerhalb des Kernelements (5) befinden, Füllmaterial um die Leitungen/Kabel herum und dazwischen und einer die Leitungen und das Füllmaterial umgebenden Schutzhülle (1), wobei die Maschine ein Ziehmittel (15), das speziell für das Kernelement (5) bestimmt ist, und aufgewikkelte Leitungen (7) und/oder Kabel (8) enthaltende Rollen (4), welche um das Kernelement (5) herum beabstandet sind und sich zur schraubenförmigen Anordnung daran um das Kernelement drehen können, und ein auf die Leitungen (7) und/oder Kabel (8) einwirkendes Ziehmittel (16) umfaßt, dadurch gekennzeichnet, daß die Maschine mindestens einen anderen Satz von Rollen (3) mit aufgewickeltem Füllmaterial in Form von länglichen Kanalelementen (6, 9) umfaßt, wobei die Rollen (3) um das Kernelement (5) herum entsprechend beabstandet sind und sich zur schraubenförmigen Anordnung der Kanalelemente (6, 9) am Kernelement (5) um das Kernelement (5) herum drehen können.

9. Maschine nach Anspruch 8, dadurch gekennzeichnet, daß jede Rolle (3, 4) zum unbehinderten Aufwickeln der länglichen Elemente (6, 7, 8, 9) freitragend an einem Drehtisch (10, 11) befestigt ist.

10. Maschine nach Anspruch 9, dadurch gekennzeichnet, daß sie mehrere Drehteller (10, 11) aufweist, die mit Rollen (3, 4) versehen sind, wobei die Drehteller in Zuführrichtung des Kabels beabstandet sind.

11. Maschine nach Anspruch 9 oder 10, dadurch gekennzeichnet, daß mindestens ein Satz von Rollen (3) auf einem Drehteller (10) nicht nur um seine eigene Längsachse (15) drehbar, sondern auch starr an dem Drehteller befestigt ist und bei einer Umdrehung des Drehtellers einer Umdrehung um seine Querachse (16) unterzogen wird.

12. Maschine nach Anspruch 9, 10 oder 11, dadurch gekennzeichnet, daß mindestens ein Satz von Rollen (4) auf einem Drehteller (11) nicht nur um seine

eigene Längsachse (17) drehbar, sondern auch schwenkbar derart mit dem Drehteller verbunden ist, daß die Längsachse (17) der Rolle bei der Drehung des Drehtellers (11) horizontal bleibt.

13. Maschine nach Anspruch 9, 10, 11 oder 12, dadurch gekennzeichnet, daß sie Ausrichtungsvorrichtungen (25) zum Begradigen der aufgewickelten Leitungen (7)/Kabel (8), bevor sie in die Kanäle (21) in dem inneren Kanalelement (6) angeordnet werden, umfaßt.

14. Maschine nach einem oder mehreren der Ansprüche 8 - 13, dadurch gekennzeichnet, daß sie am Auslaß der Maschine eine Bandwickelvorrichtung umfaßt.

Revendications

1. Procédé de fabrication et de pose d'une pluralité d'éléments allongés pour former un câble ombilical (2) comprenant une âme (5), une pluralité de conduits (7) et/ou de câbles (8) situés en dehors de l'âme (5), un matériau de charge autour et entre les conduits/les câbles et optionnellement une gaine protectrice (1) entourant les conduits et le matériau de charge, laquelle âme (5) est avancée le long d'une ligne d'amenée, les conduits (7) et/ou les câbles (8) étant amenés à l'extérieur de l'âme (5) et posés en hélice,
caractérisé en ce qu'une partie du matériau de charge, en forme d'éléments de canaux internes allongés (6), est d'abord amenée en forme hélicoïdale sur l'extérieur de l'âme (5), après quoi les conduits (7) et/ou les câbles (8) sont introduits en affleurement avec les canaux (21) dans l'élément de canal (6), et en ce que le reste du matériau de charge, en forme d'éléments de canaux extérieurs (9), est alors amené en forme hélicoïdale sur l'extérieur des conduits (7) et/ou des câbles (8) de telle sorte que les canaux (22) dans les éléments de canaux (9) soient en affleurement avec les conduits/les câbles, à mesure que tous les éléments allongés sont posés et maintenus ensemble sous forme de faisceau collectif et forment ledit câble ombilical (2).

2. Procédé selon la revendication 1, caractérisé en ce que les éléments de canaux allongés (6, 9) sont mis en contact lors de leur pose, et sont maintenus ensemble à l'aide de moyens auto-verrouillants (20) sur les bords longitudinaux des éléments de canaux (6, 9).

3. Procédé selon la revendication 1 ou 2, caractérisé en ce qu'une bande est enroulée en hélice autour des éléments allongés (6, 7, 8, 9), pour garantir de surcroît que les éléments sont maintenus ensemble après la pose.

4. Procédé selon les revendications 1 à 3, caractérisé en ce que la gaine protectrice (1) est appliquée dans une étape de production finale dans une opération continue après la pose, ou en variante, dans une opération subséquente séparée.

5. Câble ombilical (2) comprenant une âme (5), une pluralité de conduits (7) et/ou de câbles (8) situés en dehors de l'âme (5), du matériau de charge autour et entre les conduits/les câbles et une gaine protectrice (1) entourant les conduits et le matériau de charge, le matériau de charge étant posé en hélice autour de l'âme (5),
caractérisé en ce que le matériau de charge est en forme d'éléments de canaux (6) internes allongés ayant des canaux (21) ouverts sur l'extérieur, adaptés pour recevoir les conduits (7)/les câbles (8), et en forme d'éléments de canaux (9) externes allongés ayant des canaux (22) ouverts sur l'intérieur, adaptés pour recevoir et finalement recouvrir les conduits (7)/les câbles (8).

6. Câble ombilical selon la revendication 5, caractérisé en ce que les éléments de canaux allongés (6, 9) sont pourvus, le long de leurs bords latéraux, de moyens de fixation auto-verrouillants (20), qui maintiennent ensemble les éléments de canaux adjacents (6, 9) autour de l'âme (5).

7. Câble ombilical selon la revendication 5 ou 6, caractérisé en ce que l'âme (5) peut elle-même être un cordon de câble séparé (figure 9) à plus petite échelle.

8. Machine pour poser une pluralité d'éléments allongés pour former un câble ombilical (2) comprenant une âme (5), une pluralité de conduits (7) et/ou de câbles (8) situés en dehors de l'âme (5), un matériau de charge autour et entre les conduits/les câbles et une gaine protectrice (1) entourant les éléments et le matériau de charge, laquelle machine comprend un moyen de traction (15) spécifiquement pour l'âme (5) et des bobines (4) contenant des conduits (7) et/ou des câbles (8) enroulés, lesquelles bobines (4) sont espacées autour de l'âme (5) et peuvent tourner autour de l'âme pour effectuer une pose en hélice sur celle-ci, et un moyen de traction (16) agissant sur les conduits (7) et/ou les câbles (8), caractérisée en ce que la machine comprend au moins un autre jeu de bobines (3) avec du matériau de charge enroulé en forme d'éléments de canaux (6, 9) allongés, lesquelles bobines (3) sont espacées de manière correspondante autour de l'âme (5), et peuvent tourner autour de ladite âme (5) pour la pose en hélice des éléments de canaux (6, 9) sur l'âme (5).

9. Machine selon la revendication 8, caractérisée en ce que chaque bobine (3, 4) est fixée en porte-à-faux à une platine (10, 11) pour effectuer un enroulement libre des éléments allongés (6, 7, 8, 9).

10. Machine selon la revendication 9, caractérisée en ce qu'elle présente une pluralité de platines (10, 11) pourvues de bobines (3, 4), les platines étant espacées dans la direction d'amenée du câble.

11. Machine selon la revendication 9 ou 10, caractérisée en ce qu'au moins un jeu de bobines (3) sur une platine (10), en plus de pouvoir tourner autour de son propre axe longitudinal (15), est fixé rigidement à la platine et subit une rotation autour de son axe transversal (16) à chaque rotation de la platine.

12. Machine selon la revendication 9, 10 ou 11, caractérisée en ce qu'au moins un jeu de bobines (4) sur une platine (11), en plus de pouvoir tourner autour de son propre axe longitudinal (17), est attaché à la platine de manière à pouvoir pivoter de telle manière que l'axe longitudinal (17) de la bobine reste horizontal au cours de la rotation de la platine (11).

13. Machine selon la revendication 9, 10, 11 ou 12, caractérisée en ce qu'elle comprend des appareils d'alignement (25) pour redresser les conduits (7)/ les câbles (8) enroulés avant qu'ils soient posés dans les canaux (21) dans l'élément de canal interne (6).

14. Machine selon l'une ou plusieurs des revendications 8-13, caractérisée en ce qu'elle comprend un appareil d'enroulement de bande à la sortie de la machine.

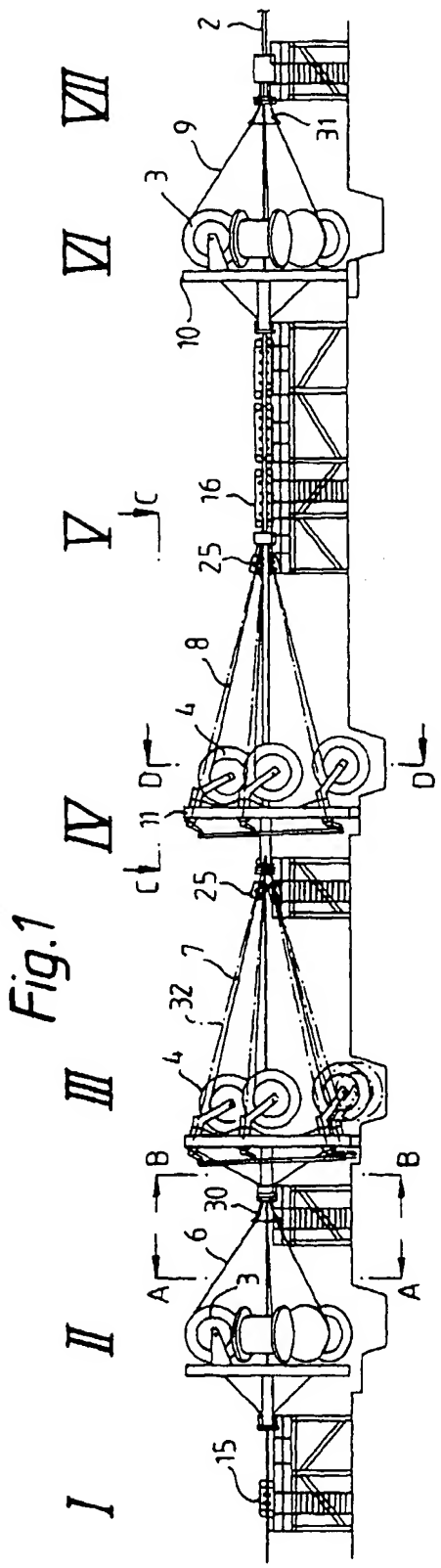


Fig.1

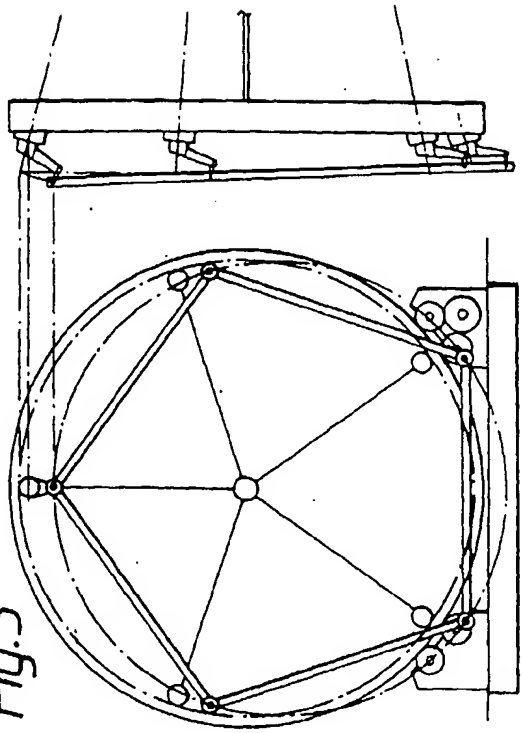


Fig.3

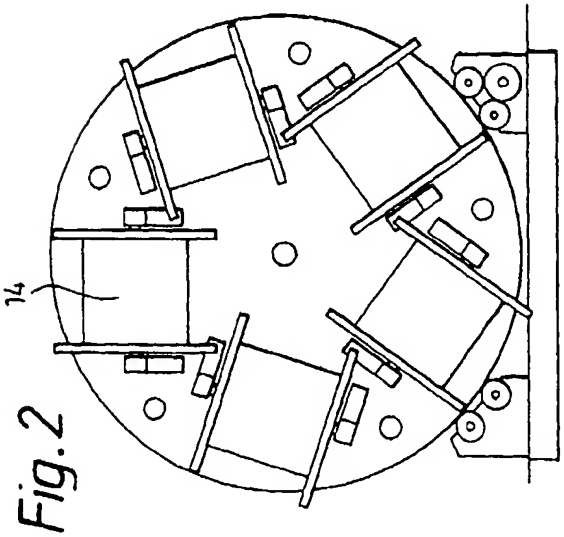


Fig.2

Fig.4

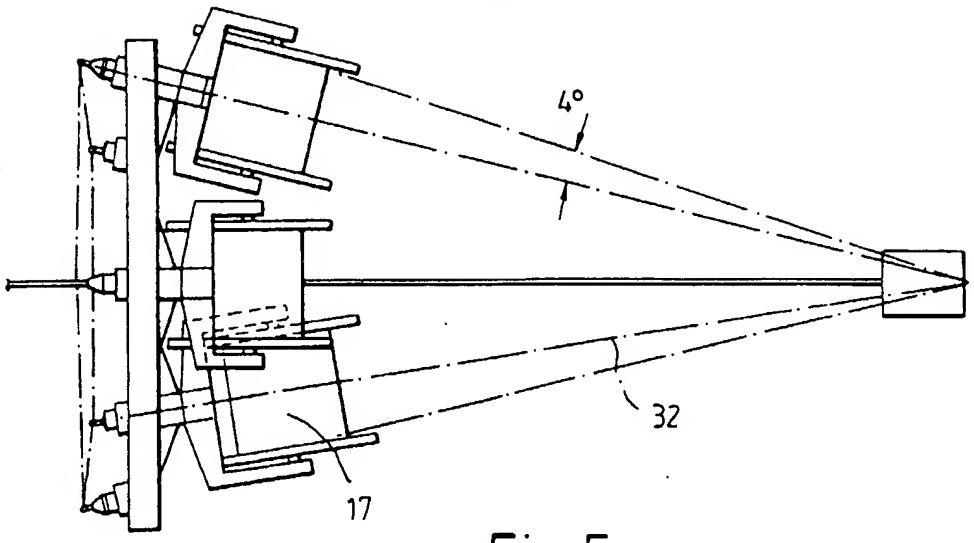
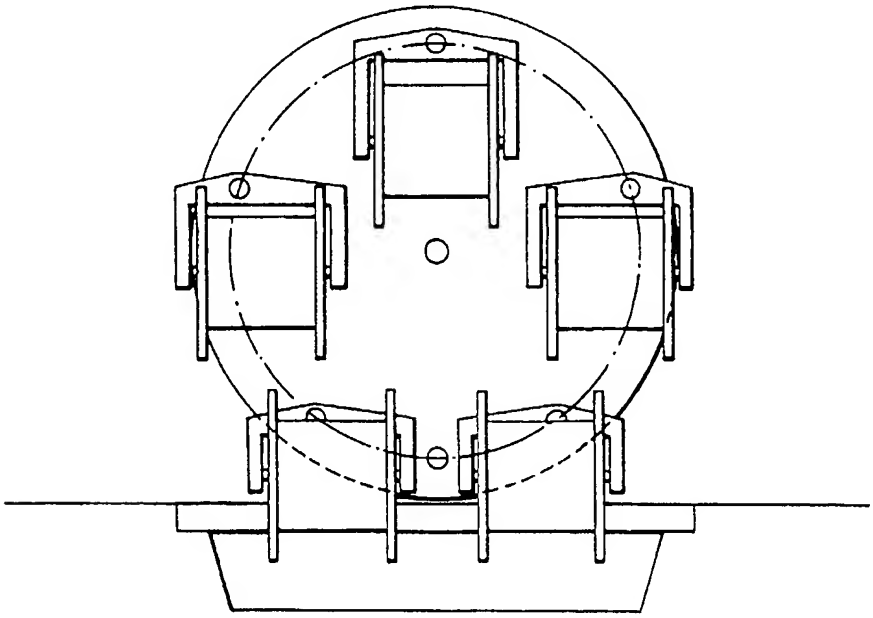


Fig.5



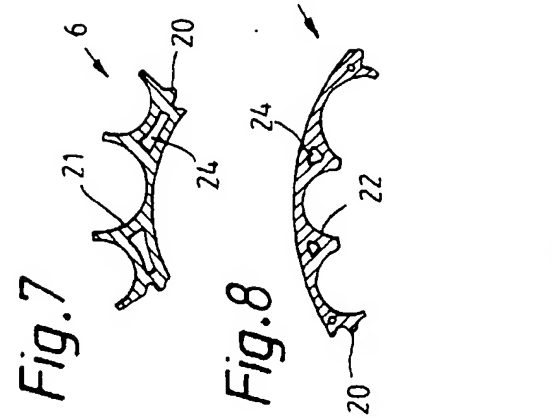


Fig.7

Fig.8

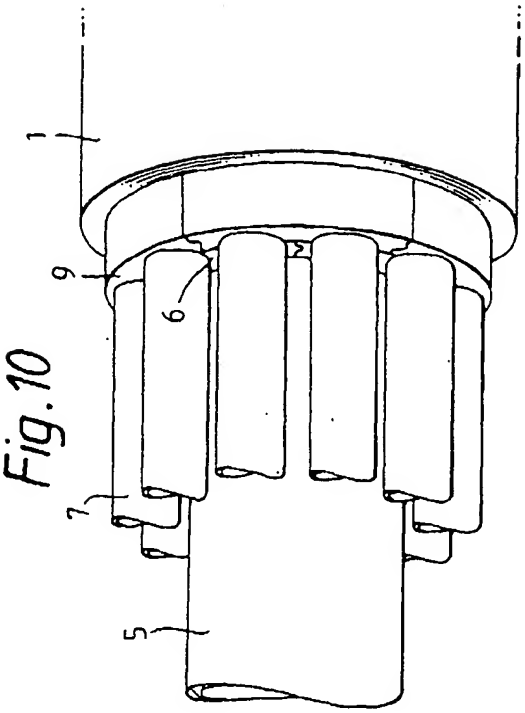


Fig.10

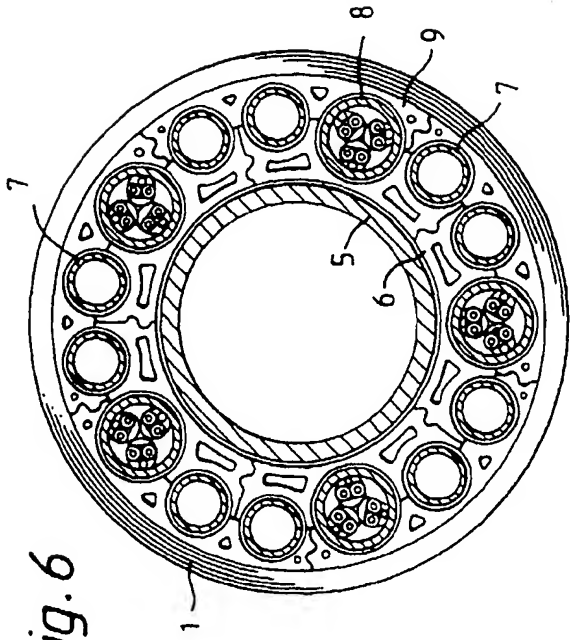


Fig.6

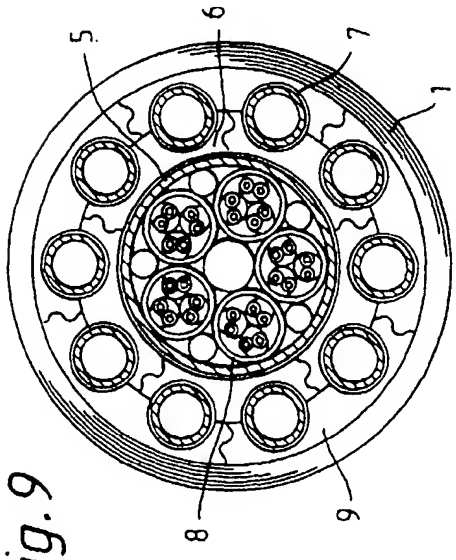


Fig.9

Fig.11

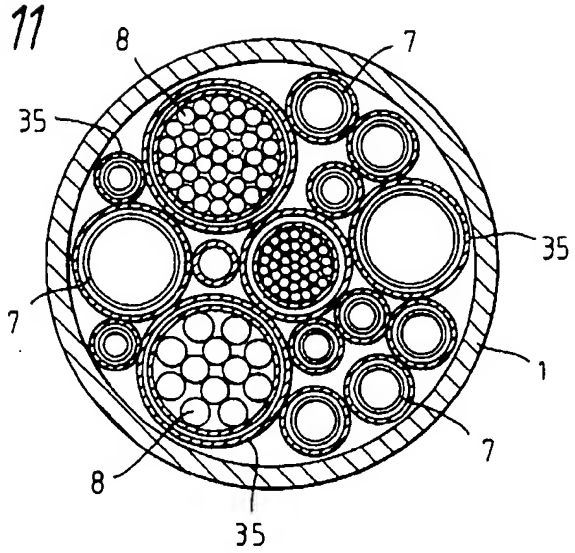


Fig.12